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ON THE PROBABLE GLACIAL ORIGIN OF CERTAIN FOLDED SLATES IN SOUTHERN ALASKA

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In the mountains east of Yakutat Bay, on the southeast coast of Alaska, a bowlder-shale terrane of unusual character has been noted by Tarr,[1] and was observed by the writer with some minuteness last summer. There is reason to believe that glaciers were instrumental in the formation of this deposit. If the supposition is correct a certain novelty attaches to the occurrence because the formation is not only old but is highly folded and slightly metamorphosed.

The rocks are well exposed in the canyons of Moser[2] and Miller Creeks and in the high bench west of them. A terrane, which is apparently the same, is that reported by Tarr from the shores of Russell Fiord.

The strata in question are several hundred feet thick and constitute a member of the Yakutat series. Typically they are conglomeratic shales, or slates, according as secondary cleavage has been developed or has not. The body of the rock is a black or dark-gray shale of relatively gritty and heterogeneous composition. In many places the matrix is definitely stratified, but elsewhere this structure is obscure or not visible.

The pebbles and bowlders in the conglomerate are the features of chief interest. Lithologically they include a large variety of rocks, some of which are known to occur not far away, while the source of others is unknown. Among them are such varieties as greenstone, gray limestone, granite, quartzite, graywacke, black slate, and flint. In size the bodies range from pebbles to bowlders of large dimensions. At least two which were more than fifty feet in length were seen imbedded in the shale, while blocks five to ten feet in diameter are common. These pebbles and bowlders are not sorted or arranged in any way whatever. Large and small are intimately mingled and are not deposited in layers as in ordinary current-laid conglomerates. The long diameters of the bowlders are not more often parallel to the stratification than oblique to it. The shape of the pebbles and bowlders is significant, since waterworn forms were seldom observed and sharply angular bodies are even less common. The great majority of the bowlders have rounded corners and edges, but are otherwise rather irregular.

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[1] He mentions shale-conglomerate as a member of the Yakutat series. *Bulletin*, No. 284 (1906), p. 62, U. S. Geol. Surv.

[2] See map in *Bull.*, No. XXI, U. S. Fish Com.

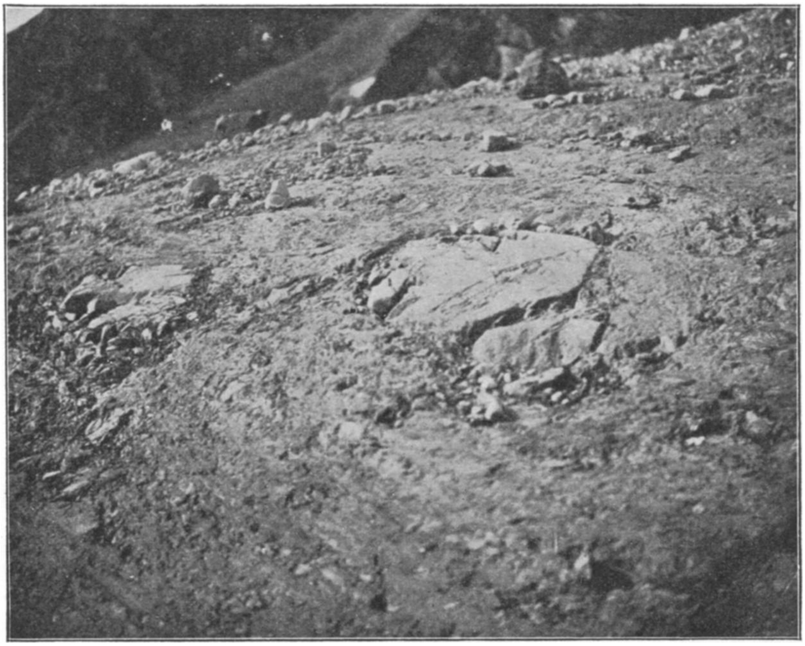

FIG. 1.—Glaciated exposure of bowlder shale in the Yakutat series. The largest bowlder is about 6 feet in diameter.

The beds of conglomerate appear to form the lower part of the Yakutat series, but the base on which they rest has not been found. Above, they seem to grade into stratified shales which are devoid of pebbles, and these in turn are followed by alternate dark shales and graywackes. The entire series has been intensely folded and broken by numerous faults. Locally, the deformation has been sufficiently severe to distort pebbles in the conglomerate and to develop secondary cleavage in the shales. A number of the pebbles and small bowlders were dug out of the matrix, and carefully examined for surface markings, such as glacial striae, but without success. The shale usually adheres more or less closely to the pebbles imbedded in it, as if it had been actually welded to their surfaces. On this account no favorable exteriors were obtained.

The age of the formation is not yet definitely known. The Yakutat series has been assigned to the Jurassic by Ulrich,[1] on the basis of fossils found in rocks near Kodiak which are thought to be the same age; but Wright[2] is inclined to regard it as somewhat older—probably late Carboniferous.

The interpretation of the shale conglomerate is beset with some difficulties arising from insufficient data, but the facts at hand seem, nevertheless, to indicate that the deposits are of glacial origin. The lack of striations on the bowlders is believed to be largely due to subsequent deformation which has defaced or obscured the original surfaces on which such markings may have been made. The large size and the variations in both size and composition among the bowlders seem incompatible with the hypothesis that the beds have been formed entirely by aqueous currents. The subangular yet irregular shapes of the bodies are also more suggestive of glacial origin than of any other. There is one feature of the formation which is sufficient, however, to prove that even if glacial it is not an ancient deposit of till or moraine, namely, the distinct stratification. The shale matrix was evidently accumulated in quiet waters where conditions favored the settling of clays and silts in successive horizontal layers. A suggestive condition now prevails in this very region: in the broad estuary called Yakutat Bay, fine sediments are doubtless now accumulating; at the same time abundant icebergs drift out from the glaciers at the head of the bay and eventually melt before they reach the Pacific. Obviously the bowlders and finer débris enclosed in this floating ice are strewn over the bottom of the bay, and it may be supposed that the result is a stratified argillaceous formation containing in random arrangement an abundance of bowlders and smaller fragments of rocks of various sizes, shapes, and compositions. It seems probable that the shale conglomerate of the Yakutat series had a similar origin—that it is in fact a marine shale enclosing the contributions of icebergs derived from local glaciers of late Paleozoic or early Mesozoic age.

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[1] E. O. Uhlrich, *Harriman Alaska Expedition* (1904), Vol. IV.

[2] C. W. Wright, in conversation with the writer at the close of the field season of 1906.